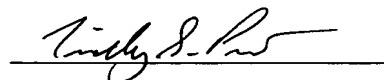


VERIFICATION OF TRANSLATION

I, Timothy S. Price, translator at Nakajima & Matsumura Patent Attorneys Office, 6F Yodogawa 5-Bankan, 3-2-1 Toyosaki, Kita-ku, Osaka, 531-0072, Japan, hereby declare that I am conversant with the English and Japanese languages and am a competent translator thereof. I further declare that to the best of my knowledge and belief the following is a true and correct translation made by me of Japanese Patent Application Publication No. 2000-129161 filed on October 21, 1998.

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(54) [TITLE OF THE INVENTION] COATING SOLUTION FOR FPD PROTECTIVE

15 FILM AND ITS PREPARATION

(57) [ABSTRACT]

[PROBLEM TO BE SOLVED] To obtain a coating solution for forming a protective film capable of suppressing polymerization of binders and uniformly dispersing MgO powder, etc., and usable 20 for a stabilized flat panel display(FPD).

[SOLUTION] This coating solution for a FPD protective film 14 is prepared by mixing a powder dispersing liquid and a binder solution. The powder dispersing liquid is prepared by mixing MgO powder or MgO powder whose surface is modified with fluorine, 25 a solvent mainly composed of an alcohol or a mixed solvent of an alcohol and an ethylene glycol derivative and a dispersant mainly composed of an ethylene glycol derivative. The binder

solution is prepared by mixing a binder mainly composed of a magnesium alkoxide or magnesium acetylacetone and a solvent mainly composed of an alcohol or a mixed solvent of an alcohol and an ethylene glycol derivative and an additive mainly composed  
5 of an ethylene glycol derivative.

[CLAIMS]

[CLAIM 1] An FPD protective film coating solution mixed from a powder dispersing fluid and a binder solution, wherein  
10 the powder dispersing fluid is prepared by mixing an MgO powder or MgO powder whose surface is modified with fluorine, a mixed solvent of an ethylene glycol derivative and an alcohol or a solvent mainly composed of an alcohol, and a dispersant mainly composed of an ethylene glycol derivative, and  
15 the binder solution is prepared by mixing a binder mainly composed of magnesium alkoxide or magnesium acetylacetone, a mixed solvent of an ethylene glycol derivative and an alcohol or a solvent mainly composed of an alcohol, and an additive mainly composed of an ethylene glycol derivative.

20

[CLAIM 2] The FPD protective film coating solution of claim 1, wherein

the ethylene glycol derivative is diethanolamine.

25 [CLAIM 3] A preparation method for an FPD protective film coating solution, comprising the steps of:  
preparing a powder dispersing fluid by mixing an MgO powder

or MgO powder whose surface is modified with fluorine, a mixed solvent of an ethylene glycol derivative and an alcohol or a solvent mainly composed of an alcohol, and a dispersant mainly composed of an ethylene glycol derivative;

5 preparing a binder solution by mixing a binder mainly composed of magnesium alkoxide or magnesium acetylacetone, a mixed solvent of an ethylene glycol derivative and an alcohol or a solvent mainly composed of an alcohol, and an additive mainly composed of an ethylene glycol derivative; and

10 mixing the powder dispersing fluid and the binder solution.

[CLAIM 4] An FPD protective film manufactured using the FPD protective film coating solution of claims 1 or 2.

15

[CLAIM 5] An FPD having an FPD protective film manufactured using the FPD protective film coating solution of claims 1 or 2.

20 [DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[FIELD OF THE INVENTION]

The present invention relates to a coating solution for forming a protective film usable in a FPD (Flat Panel Display) such as a PDP (Plasma Display Panel) or PALC (Plasma Addressed Liquid Crystal Display), and a preparation method for the coating solution, and moreover to an FPD protective film manufactured

using the coating solution, and an FPD having the FPD protective film.

[0002]

[DESCRIPTION OF RELATED ART]

5       Conventionally, for this type of coating solution there  
is disclosed a coating composition that is basically constituted  
from a partial hydrolysate from a metal compound that has a  
hydrolysis-capable reaction site (JP,H8-325522,A). In this  
coating compound, the partial hydrolysate is obtained by the  
10 hydrolyzation of the metal compound at its hydrolysis-capable  
reaction site in the presence of a stoichiometric-or-below amount  
of water. A thin-film protective film can be obtained from a  
coating compound with this constitution by first creating a partial  
hydrolysate sol by performing partial hydrolyzation at the  
15 hydrolysis-capable reaction site, and then applying this sol to  
a base and performing baking to create a corresponding metal oxide  
film. The film strength of the protective film and adhesion to  
the substrate can be improved since the hydrolysate in the partial  
hydrolysate sol does not separate out.

20       [0003]

Also, Japanese Patent Application Publication No.  
H8-329844 discloses an AC-type plasma display panel having a  
protective film manufactured using the aforementioned coating  
compound. In this AC-type plasma display panel, a gas discharge  
25 space is sandwiched between a front substrate and a back substrate  
that are disposed in opposition, electrodes covered by a dielectric  
layer are formed in pairs on one or both of the substrates, and

the protective film is formed on the dielectric layer. In an AC-type plasma display panel having such a structure, an alkaline earth metal oxide film (e.g., a magnesium oxide film) is formed as the protective film by preparing a coating solution that 5 basically includes a partial hydrolysate from an alkaline earth metal compound (e.g., a magnesium compound), that has a hydrolysis-capable reaction site, applying the coating solution to dielectric layer that covers a substrate, and applying heat. This enables the use of a chemical method to easily and stably 10 form a protective film at a sufficiently low film-formation temperature. This also enables an improvement in the film strength of the protective film and adhesion to the substrate, and the reduction of the discharge initializing voltage and drive voltage of an AC-type PDP using this protective film.

15 [0004]

On the other hand, there are protective film formation methods that are low cost and superior for mass production compared with conventional methods of forming an FPD protective film using a vacuum process such as electron beam vapor deposition or a 20 sputtering method. Such methods include a wet process such a screen printing method, spin-coat method and spray-coat method, and use a paste or coating solution that includes an MgO powder, a mixed powder of an MgO powder and an Mg(OH)<sub>2</sub> powder, or a rare earth oxide powder dispersed in a binder (e.g., JP,H3-67437,A 25 JP,H7-220640,A, JP,H7-147136,A, JP,H7-335134,A, JP,H8-111177,A, JP,H8-111178,A, JP,H8-212917,A, JP,H6-325696,A, JP,H8-167381,A, JP,H8-264125,A, JP,H9-12940,A, JP,H9-12976,A, JP,H8-96718,A,

JP, H6-316671, A, JP, H9-208851, A, etc.)

[0005]

[PROBLEMS SOLVED BY THE INVENTION]

However, in the coating compound disclosed in Japanese Patent Application Publication No. H8-325522 and the AC-type plasma display panel disclosed in Japanese Patent Application Publication No. H8-329844, crystallization in the protective film is low (amorphous) due to the formation of the protective film by pyrolysis of organic materials. Also, in the protective film formation method using the wet process disclosed in Japanese Patent Application Publication No. H3-67437, it is difficult to obtain a stable coating compound due to the binder having polymerization characteristics, and the progression of the polymerization due to heat generated during dispersion of powders and adsorbed water on the surface of the MgO powder and the like. As a result, defects such as radiating lines, cracks, interference irregularities and the like occur in a protective film manufactured using this coating compound, and there is insufficient transparency.

[0006]

An aim of the present invention is to provide a coating solution that is capable of suppressing polymerization, stable, and in which MgO powder, etc. is uniformly dispersed, and preparation method for the coating solution. Another aim of the present invention is to provide an FPD protective film with improved strength, crystallization, and adhesion to a substrate, lacking defects such as radiating lines, cracks, or interference irregularities, and moreover having favorable transparency, and

an FPD having this FPD protective film.

[0007]

[MEANS TO SOLVE THE PROBLEMS]

The invention of claim 1 is an FPD protective film coating  
5 solution mixed from a powder dispersing fluid and a binder solution,  
wherein the powder dispersing fluid is prepared by mixing an MgO  
powder or MgO powder whose surface is modified with fluorine,  
a mixed solvent of an ethylene glycol derivative and an alcohol  
or a solvent mainly composed of an alcohol, and a dispersant mainly  
10 composed of an ethylene glycol derivative, and the binder solution  
is prepared by mixing a binder mainly composed of magnesium alkoxide  
or magnesium acetylacetone, a mixed solvent of an ethylene glycol  
derivative and an alcohol or a solvent mainly composed of an alcohol,  
and an additive mainly composed of an ethylene glycol derivative.  
15 In the FPD protective film coating liquid of claim 1, the dispersant  
is added in order to cause the MgO powder, etc. to sufficiently  
and evenly disperse in the powder dispersing liquid, and the  
additive acts as a stabilizing agent to suppress polymerization  
of the binder and stabilize the coating solution. As a result,  
20 given that a binder with polymerization characteristics is not  
present during preparation of the powder dispersing liquid,  
polymerization of the binder does not occur even if heat is generated  
from the dispersion of the MgO powder, etc. or water is adsorbed  
to the surface of the MgO powder, etc. Also, even if the powder  
25 dispersing liquid is mixed with a binder solution, the binder  
will not polymerize since it has already been stabilized by the  
additive, and it is possible to obtain a stable coating solution

in which the MgO powder, etc. is evenly distributed.

[0008]

The invention of claim 2 is the invention of claim 1 in which the ethylene glycol derivative is diethanolamine. In the 5 FPD protective film coating solution of claim 2, the MgO powder, etc. is sufficiently and evenly dispersed in the powder dispersing liquid by diethanolamine.

[0009]

The invention of claim 3 is a preparation method for an 10 FPD protective film coating solution, including the steps of: preparing a powder dispersing fluid by mixing an MgO powder or MgO powder whose surface is modified with fluorine, a mixed solvent of an ethylene glycol derivative and an alcohol or a solvent mainly composed of an alcohol, and a dispersant mainly composed of an 15 ethylene glycol derivative; preparing a binder solution by mixing a binder mainly composed of magnesium alkoxide or magnesium acetylacetone, a mixed solvent of an ethylene glycol derivative and an alcohol or a solvent mainly composed of an alcohol, and an additive mainly composed of an ethylene glycol derivative; 20 and mixing the powder dispersing fluid and the binder solution.

In the preparation method for an FPD protective film coating solution of claim 3, it is possible to relatively easily prepare the coating solution in a short period of time, without the need for large-scale equipment such as is required for a protective 25 film formation method by an electron beam deposition method or a sputtering method.

[0010]

The invention of claim 4 is, as shown in Fig.1, an FPD protective film manufactured using the FPD protective film coating solution of claims 1 or 2. In the FPD protective film of claim 4, the protective film is formed by the powder dispersed evenly 5 in the coating solution combining with magnesia in the binder when sintered, thereby enabling the formation of a protective film with favorable film strength and crystallization properties, and a high degree of adhesion to a substrate. Also, the protective film has a favorable appearance and transparency due to a lack 10 of defects such as radiating lines, cracks, and interference irregularities.

[0011]

The invention of claim 5 is, as shown in Fig.1, an FPD having an FPD protective film manufactured using the FPD protective film coating solution of claims 1 or 2. The FPD having the FPD protective film of claim 5 enables an improvement in properties 15 of the FPD.

[0012]

[EMBODIMENTS OF THE INVENTION]

20 Next is a description of an embodiment of the preset invention. An FPD protective film coating solution is prepared by mixing two liquids, which are a powder dispersing liquid composed of a powder, a powder solvent and a dispersant, and a binder solution composed of a binder, a binder solvent and an additive. The powder 25 is formed from an MgO powder or an MgO powder whose surface has been modified with fluorine (hereinafter, called modified MgO powder), the powder dispersing liquid is formed by mixing an

ethylene glycol derivative with an alcohol or a solvent mainly composed of an alcohol, and the dispersant is formed from a dispersant mainly composed of a an ethylene glycol derivative. The MgO powder and modified MgO powder have an average particle 5 diameter of 50 Å to 5 µm, or preferably 100 Å to 2000 Å. Also, the modified MgO powder is an MgO powder whose surface is covered by a fluoride layer, this fluoride layer can be obtained by the reaction between the MgO and a gas-phase fluorinating agent, and it is preferable for the gas-phase fluorinating agent to be fluorine 10 gas or hydrogen fluoride in consideration of high reactivity and general versatility.

[0013]

The solvent mainly composed of an alcohol may be methanol, ethanol, propanol, alpha-terpineol, etc., and ethylene glycol 15 derivative may be diethanolamine, ethylene glycol, diethylene glycol, 1-methoxy-2-propanol, 1-ethoxy-2-propanol, methyl cellosolve, ethylcellosolve, isopropyl glycol, butyl cellosolve, etc. Also, the mixed solvent of an alcohol and an ethylene glycol derivative may be, for example, a mixture of methanol and isopropyl 20 glycol at a predetermined ratio (e.g., 20:80 by weight). The dispersant mainly composed of an ethylene glycol derivative may be the aforementioned ethylene glycol derivative itself, that is, diethanolamine, diethylene glycol, etc.

[0014]

25 The binder may be formed from a binder mainly composed of magnesium alkoxide or magnesium acetylacetone, the binder solution may be formed from, similarly to the powder dispersing

liquid, a solution mainly composed of an ethylene glycol derivative and an alcohol or a solvent mainly composed of an alcohol, the additive may be formed from, similarly to the dispersant, an additive mainly composed of an ethylene glycol derivative, and  
5 the binder solution is prepared by mixing the binder, the binder solution, and the additive. The binder mainly composed of magnesium alkoxide may be magnesium dimethoxide, magnesium diethoxide, magnesium-1-methoxy-2-propylate, magnesium dipropoxide, etc.; the binder mainly composed of magnesium  
10 acetylacetone may be a chelate compound of a beta-diketone such as an acetylacetone of magnesium, a benzoylacetone, or dibenzoylmethane, and a keto-acid ester such as an ethyl acetoacetate, or benzoylacetic acid ethyl.

[0015]

15 Next is a description of a preparation method for a coating solution having such a structure. First, the powder dispersing liquid is prepared by mixing the powder, the powder solvent, and the dispersant in a predetermined ratio. Also, the binder solution is prepared by mixing the binder, the binder solvent, and the  
20 additive in a predetermined ratio. Next, the coating solution is obtained by mixing the powder dispersing liquid and the binder solution in a predetermined ratio. A paint shaker, roll mill (e.g., a 3 roll mill) or the like can be used to mix the above liquids.

[0016]

25 The mixture ratio (wt%) of the powder, the powder solvent, and the dispersant is (0.1-30):(60-98):(0.01-10), or preferably (5-25):(70-95):(0.5-2.5), and the mixture ratio (wt%) of the

binder, the binder solvent, and the additive is (0.1-40):(40-95):(0.1-50), or preferably (2-25):(50-90):(5-40). The aforementioned mixture ratios represent the ratios of the main components (powder, powder solvent, dispersant, binder, 5 binder solvent, and additive) in terms of 100 wt% of a coating solution prepared by mixing the powder dispersing liquid and the binder solution. The dispersant in the powder dispersing liquid is added to cause the powder to sufficiently and evenly disperse in the powder dispersing liquid, and the additive in the binder 10 solution acts as a stabilizing agent to suppress polymerization of the binder. As a result, given that a binder with polymerization characteristics is not present during preparation of the powder dispersing liquid (i.e., when the powder is dispersed), polymerization of the binder does not occur even if heat is generated 15 from the dispersion of the MgO powder, etc. or water is adsorbed to the surface of the MgO powder, etc. Also, even if the powder dispersing liquid is mixed with a binder solution, the binder will not polymerize since it has already been stabilized by the additive, and it is possible to obtain a stable coating solution 20 in which the MgO powder, etc. is evenly distributed.

[0017]

The protective film is formed on a substrate by applying the coating solution prepared as mentioned above, drying at a temperature of 50 to 200°C, and then baking in air at a temperature 25 of 300 to 650°C. The method for applying the coating solution may be a spray-coat method, a screen printing method, a spray-coat method, a dip-coat method, a doctor blade method, or the like.

This protective film can have favorable crystallization and strength properties, and good adhesion to the substrate since the powder dispersed evenly in the coating solution combines with the magnesia in the binder when sintered. The protective film 5 also lacks defects such as radiating lines, cracks, and interference irregularities, and has a favorable appearance and transparency. Therefore, it is possible to improve PDP properties when this protective film is used in an AC-type PDP as shown in Fig.1. More specifically, it is possible to reduce the discharge 10 initializing voltage and drive voltage of the PDP..

[0018]

Note that as shown in Fig.1, the PDP is constituted from a back glass substrate 11 on which a front glass substrate 13 has been laid via barrier walls 12 formed at a predetermined interval. 15 Display electrodes 16, a transparent dielectric layer 17, and a protective layer 14 are sequentially formed on a surface of the front glass substrate 13 that faces the back glass substrate 11. A plurality of partitioned discharge cells 18 are formed by the back glass substrate 11, the front glass substrate 13 and 20 the barrier walls 12, and address electrodes 19 are formed in the discharge cells 18 on the back glass substrate 11, so as to face the display electrodes 16. Also, character 21 in Fig.1 is a phosphor layer formed in one of the discharge cells 18 on side surfaces of the barrier walls 12 and on a top surface of the back 25 glass substrate 11. Note that although the FPD is a PDP in the present embodiment, the FPD may be a PALC or the like.

[0019]

[WORKING EXAMPLE]

Next are detailed descriptions of working examples of the present invention, as well as comparative examples.

*Working Example 1*

5       The powder dispersing liquid was prepared by using a paint shaker to disperse 3.0 wt% of an MgO powder (Ube Materials, average particle diameter of 500 Å, and hereinafter called MgO powder 1) as the powder, in 46.7 wt% of a mixed solvent of methanol and isopropyl glycol in a 20:80 mixture ratio (hereinafter, called 10 a mixed solvent of methanol and isopropyl glycol) as the solvent, with 0.3 wt% of diethanolamine as the dispersant. The binder solution was prepared by mixing 2.0 wt% of magnesium diethoxide as the binder, 44.0 wt% of the mixed solvent of methanol and isopropyl glycol as the solvent, and 4.0 wt% of diethanolamine 15 as the additive. The coating solution was obtained by mixing the above powder dispersing liquid and binder solution. This coating solution was formed into a film on a glass substrate by a sputtering method, dried at 60°C, and baked in air at 580°C. The resulting protective film was working example 1.

20       [0020]

*Working Example 2*

The powder dispersing liquid was prepared using 10.0 wt% of the MgO powder 1 as the powder, 39.0 wt% of ethylcellosolve as the solvent, and 1.0 wt% of diethanolamine as the dispersant. 25       The binder solution was prepared using 2.0 wt% of magnesium diethoxide as the binder, 44.0 wt% of ethylcellosolve as the solvent,

and 4.0 wt% of diethanolamine as the additive. Other than the differences above, the protective film was formed on a glass substrate similarly to working example 1. The resulting protective film was working example 2.

5 [0021]

*Working Example 3*

The powder dispersing liquid was prepared using 3.0 wt% of MgO powder whose surface has been modified with fluorine (constituent MgO particles: Ube Materials, average particle diameter of 500 Å, and hereinafter called modified MgO powder 1) as the powder, 46.7 wt% of the mixed solvent of methanol and isopropyl glycol as the solvent, and 0.3 wt% of diethanolamine as the dispersant. The binder solution was prepared using 2.0 wt% of magnesium diethoxide as the binder, 44.0 wt% of the mixed solvent of methanol and isopropyl glycol as the solvent, and 4.0 wt% of diethanolamine as the additive. Other than the differences above, the protective film was formed on a glass substrate similarly to working example 1. The resulting protective film was working example 3.

20 [0022]

*Working Example 4*

The powder dispersing liquid was prepared using 10.0 wt% of the modified MgO powder 1 as the powder, 39.0 wt% of ethylcellosolve as the solvent, and 1.0 wt% of diethanolamine 25 as the dispersant. The binder solution was prepared using 2.0 wt% of magnesium diethoxide as the binder, 44.0 wt% of

ethycellosolve as the solvent, and 4.0 wt% of diethanolamine as the additive. Other than the differences above, the protective film was formed on a glass substrate similarly to working example 1. The resulting protective film was working example 4.

5

[0023]

*Working Example 5*

The powder dispersing liquid was prepared using 3.0 wt% of the MgO powder 1 as the powder, 46.7 wt% of the mixed solvent of methanol and isopropyl glycol as the solvent, and 0.3 wt% of 10 diethanolamine as the dispersant. The binder solution was prepared using 10.0 wt% of magnesium diethoxide as the binder, 25.0 wt% of the mixed solvent of methanol and isopropyl glycol as the solvent, and 15.0 wt% of diethanolamine as the additive. Other than the differences above, the protective film was formed 15 on a glass substrate similarly to working example 1. The resulting protective film was working example 5.

[0024]

*Working Example 6*

The powder dispersing liquid was prepared using 3.0 wt% 20 of the MgO powder 1 as the powder, 46.7 wt% of the mixed solvent of methanol and isopropyl glycol as the solvent, and 0.3 wt% of diethanolamine as the dispersant. The binder solution was prepared using 2.0 wt% of magnesium-1-methoxy-2-propylate [D] as the binder, 44.0 wt% of the mixed solvent of methanol and 25 isopropyl glycol as the solvent, and 4.0 wt% of diethanolamine as the additive. Other than the differences above, the protective

film was formed on a glass substrate similarly to working example

1. The resulting protective film was working example 6.

[0025]

*Working Example 7*

5 The powder dispersing liquid was prepared using 3.0 wt% of the MgO powder 1 as the powder, 46.7 wt% of ethylcellosolve as the solvent, and 0.3 wt% of diethylene glycol as the dispersant. The binder solution was prepared using 2.0 wt% of magnesium benzoylacetone as the binder, 44.0 wt% of ethycellosolve as 10 the solvent, and 4.0 wt% of diethylene glycol as the additive. Other than the differences above, the protective film was formed on a glass substrate similarly to working example 1. The resulting protective film was working example 7.

[0026]

15 *Working Example 8*

The powder dispersing liquid was prepared by using a 3 roll mill to mix 3.0 wt% of an MgO powder manufactured by a vapor-phase method (Ube Materials, average particle diameter 100 Å, and hereinafter called MgO powder 2) as the powder, in 16.7 20. wt% of alpha-terpineol as the solvent, with 0.3 wt% of diethanolamine as the dispersant. The binder solution was prepared by mixing 20.0 wt% of magnesium diethoxide as the binder, 40.0 wt% of alpha-terpineol as the solvent, and 20.0 wt% of diethanolamine as the additive. The coating solution was obtained 25 by mixing the above powder dispersing liquid and binder solution. This coating solution was formed into a film on a glass substrate

by a screen printing method, dried at 150°C, and baked in air at 580°C. The resulting protective film was working example 8.

[0027]

*Working Example 9*

5       The powder dispersing liquid was prepared using 3.0 wt% of MgO powder whose surface has been modified with fluorine (constituent MgO particles: Ube Materials, average particle diameter of 100 Å, and hereinafter called modified MgO powder 2) as the powder, 16.7 wt% of alpha-termineol as the solvent, 10 and 0.3 wt% of diethanolamine as the dispersant. The binder solution was prepared using 20.0 wt% of magnesium diethoxide as the binder, 40.0 wt% of alpha-termineol as the solvent, and 20.0 wt% of diethanolamine as the additive. Other than the differences above, the protective film was formed on a glass substrate similarly 15 to working example 8. The resulting protective film was working example 9.

[0028]

*Working Example 10*

The powder dispersing liquid was prepared using 3.0 wt% 20 of the MgO powder 2 as the powder, 16.7.0 wt% of alpha-termineol as the solvent, and 0.3 wt% of diethylene glycol as the dispersant. The binder solution was prepared using 15.0 wt% of magnesium benzoylacetone as the binder, 45.0 wt% of alpha-termineol as the solvent, and 20.0 wt% of diethylene glycol as the additive. 25 Other than the differences above, the protective film was formed on a glass substrate similarly to working example 8. The resulting

protective film was working example 10.

[0029]

*Comparative Example 1*

The powder dispersing liquid was prepared by initially  
5 using a paint shaker to mix 3.0 wt% of the MgO powder 1 as the  
powder, 90.7 wt% of the mixed solvent of methanol and isopropyl  
glycol as the solvent, 4.3 wt% of diethanolamine as the dispersant,  
and 2.0 wt% of magnesium diethoxide as the binder. Other than  
the differences above, the protective film was formed on a glass  
10 substrate similarly to working example 1. The resulting  
protective film was comparative example 1.

[0030]

*Comparative Example 2*

The powder dispersing liquid was prepared by initially  
15 using a 3 roll mill to mix 3.0 wt% of the MgO powder 2 as the  
powder, 56.7 wt% of alpha-termineol as the solvent, 20.3 wt% of  
diethanolamine as the dispersant, and 20.0 wt% of magnesium  
diethoxide as the binder. Other than the differences above, the  
protective film was formed on a glass substrate similarly to working  
20 example 1. The resulting protective film was comparative example  
2.

[0031]

*Comparative Experiment 1 and Evaluation*

Table 1 shows constituents of the coating solutions for  
25 forming (using a spin-coat method) the protective films of working  
examples 1 to 7 and comparative example 1. The appearance, visible

light transmissivity, and the pencil hardness of each of the protective films of working examples 1 to 7 and comparative example 1 were measured in the following ways. The appearance of the protective films was visually observed, and whether or not there 5 were defects such as radiating lines, cracks, or interference irregularities was evaluated. Specifically, good protective films without defects are marked with O, those with slight defects are marked with Δ, and those with a relatively large number of defects are marked with X. The visible light transmissivity is 10 represented as a transmissivity when the protective films were irradiated with a predetermined wavelength of visible light (550 nm). The pencil hardness was evaluated pursuant to JIS K 5400. Specifically, there were provide pencils with predetermined hardnesses (from B to 6B), the protective films were scratched 15 by the pencils with a predetermined force in order from the softest pencil (6B) to the hardest pencils (5B-B), and the hardness of the first pencil to scratch the protective film was determined to be the pencil hardness thereof. These results are shown in Table 1.

[0032]

Table 1

	Powder Dispersing Liquid			Binder Solution			Protective Film (spin-coat method)		
	Powder (wt%)	Solvent (wt%)	Dispersant (wt%)	Binder (wt%)	Solvent (wt%)	Additive (wt%)	Appearance	Visible Light Transmissivity (%)	Pencil Hardness
Working Example 1	A (3.0)	F (46.7)	H (0.3)	C (2.0)	F (44.0)	H (4.0)	○	94.6	3B
Working Example 2	A (10.0)	G (39.0)	H (1.0)	C (2.0)	G (44.0)	H (4.0)	△	90.8	5B
Working Example 3	B (3.0)	F (46.7)	H (0.3)	C (2.0)	F (44.0)	H (4.0)	○	95.2	4B
Working Example 4	B (10.0)	G (39.0)	H (1.0)	C (2.0)	G (44.0)	H (4.0)	○	92.1	4B
Working Example 5	A (3.0)	F (46.7)	H (0.3)	C (10.0)	F (25.0)	H (15.0)	○	96.6	3B
Working Example 6	A (3.0)	F (46.7)	H (0.3)	D (2.0)	F (44.0)	H (4.0)	○	91.2	4B
Working Example 7	A (3.0)	G (46.7)	I (0.3)	E (2.0)	G (44.0)	I (4.0)	△	87.8	5B
Comparative Example 1	A (3.0)	F (90.7)	H (4.3)	C (2.0)	-	-	×	62.7	6B or lower

[0033]

5 Note that in Table 1, A is MgO powder (Ube Materials, average particle diameter of 500 Å), B is the MgO powder whose surface has been modified with fluorine (constituent MgO powder: Ube materials, average particle diameter 500 Å), C is magnesium diethoxide binder ( $Mg(OEt)_2$ ), D is 10 magnesium-1-methoxy-2-propylate binder ( $Mg(OCH(CH_3)CH_2OCH_3)_2$ ), E is magnesium benzoylacetone (Mg(bzac)<sub>2</sub>), F is the mixed solvent composed of methanol and isopropyl glycol mixed at a ratio of 20:80 by weight, G is ethylcellosolve solvent, H is diethanolamine dispersant and additive, and I is diethylene glycol dispersant 15 and additive.

[0034]

As is clear from Table 1, while the protective films of working examples 1 to 7 had good appearances and almost no defects such as radiating lines, cracks, or interference irregularities, 5 the protective film in comparative example 1 had relatively many radiating lines, cracks, and/or interference irregularities. Also, while the visible light transmissivity of the protective films of working examples 1 to 7 were very high at 87.8% to 96.6%, the visible light transmissivity of the protective film of 10 comparative example 1 was low at 62.7%. Moreover, while the pencil hardness of the protective films of working examples 1 to 7 were relatively hard at 3B to 5B, the protective film of comparative example 1 was soft at 6B or below.

[0035]

15 *Comparative Example 2 and Evaluation*

Table 2 shows constituents of the coating solutions for forming (using a screen printing method) the protective films of working examples 8 to 10 and comparative example 2. The appearance, visible light transmissivity, and the pencil hardness 20 of each of the protective films of working examples 8 to 10 and comparative example 2 were measured in the same way as in the above comparative experiment 1. These results are shown in Table 2.

[0036]

Table 2

	Powder Dispersing Liquid			Binder Solution			Protective Film (spin-coat method)		
	Powder (wt%)	Solvent (wt%)	Dispersant (wt%)	Binder (wt%)	Solvent (wt%)	Additive (wt%)	Appearance	Visible Light Transmissivity (%)	Pencil Hardness
Working Example 8	A (3.0)	E (16.7)	F (0.3)	C (20.0)	E (40.0)	F (20.0)	O	92.1	5B
Working Example 9	B (3.0)	E (16.7)	F (0.3)	C (20.0)	E (40.0)	F (20.0)	O	92.2	5B
Working Example 10	A (3.0)	E (16.7)	G (0.3)	D (15.0)	E (45.0)	G (20.0)	Δ	87.8	4B
Comparative Example 2	A (3.0)	E (56.7)	F (20.3)	C (20.0)	-	-	X	46.3	6B or lower

[0037]

Note that in Table 2, A is MgO powder (Ube Materials, average particle diameter of 100 Å), B is the MgO powder whose surface has been modified with fluorine (constituent MgO powder: Ube materials, average particle diameter 100 Å), C is magnesium diethoxide binder ( $Mg(OEt)_2$ ), D is magnesium benzoylacetoneate ( $Mg(bzac)_2$ ) binder, E is, F is alpha-terpineol dispersant and additive, and G is ethylene glycol dispersant and additive.

[0038]

As is clear from Table 2, while the protective films of working examples 8 to 10 had good appearances and almost no defects such as radiating lines, cracks, or interference irregularities, the protective film in comparative example 2 had relatively many radiating lines, cracks, and/or interference irregularities. Also, while the visible light transmissivity of the protective films of working examples 8 to 10 were very high at 87.8% to 92.2%,

the visible light transmissivity of the protective film of comparative example 2 was low at 46.3%. Moreover, while the pencil hardness of the protective films of working examples 8 to 10 were relatively hard at 4B to 5B, the protective film of comparative example 2 was soft at 6B or below.

[0039]

[EFFECTS OF THE INVENTION]

According the present invention, and as mentioned above, the coating solution is a compound of two solutions, which are a powder dispersing fluid prepared by sufficiently and evenly dispersing an MgO powder, etc. in a powder dispersing liquid by a dispersant, and a binder solution prepared by stabilizing a binder by an additive, thereby making it possible to obtain a stable coating solution that can suppress polymerization of the binder, and in which the MgO powder, etc. is even dispersed. In other words, given that a binder with polymerization characteristics is not present during preparation of the powder dispersing liquid, polymerization of the binder does not occur even if heat is generated from the dispersion of the MgO powder, etc. or water is adsorbed to the surface of the MgO powder, etc. Also, even if the powder dispersing liquid is mixed with a binder solution, the binder will not polymerize since it has already been stabilized by the additive, and it is possible to obtain a stable coating solution in which the MgO powder, etc. is evenly distributed.

[0040]

Also, using diethanolamine as the ethylene glycol enables

the sufficient and even dispersion of the MgO powder, etc. in the powder dispersing liquid. Also, preparing the powder dispersing liquid by mixing the MgO powder, etc., the powder solvent, and the dispersant, preparing the binder solution by mixing the 5 binder, the binder solvent, and the additive, and preparing the coating solution by mixing the above powder dispersing fluid and binder solution enables the relatively simple preparation of a coating solution in a short period of time, without the need for large-scale equipment, compared with an electron beam vapor 10 deposition method or a sputtering method which require large-scale equipment.

[0041]

Manufacturing an FPD protective film using the above coating solution enables the formation of a protective film with 15 favorable crystallization and strength properties, and good adhesion to the substrate since the powder dispersed evenly in the coating solution combines with the magnesia in the binder when sintered. The protective film also lacks defects such as radiating lines, cracks, and interference irregularities, and 20 has a favorable appearance and transparency. Moreover, it is possible to improve FDP properties when this protective film is used in an FDP having an FDP protective film. In particular, using the coating solution to manufacture a PDP having the PDP protective film makes it possible to reduce the discharge initializing voltage 25 and drive voltage of the PDP.

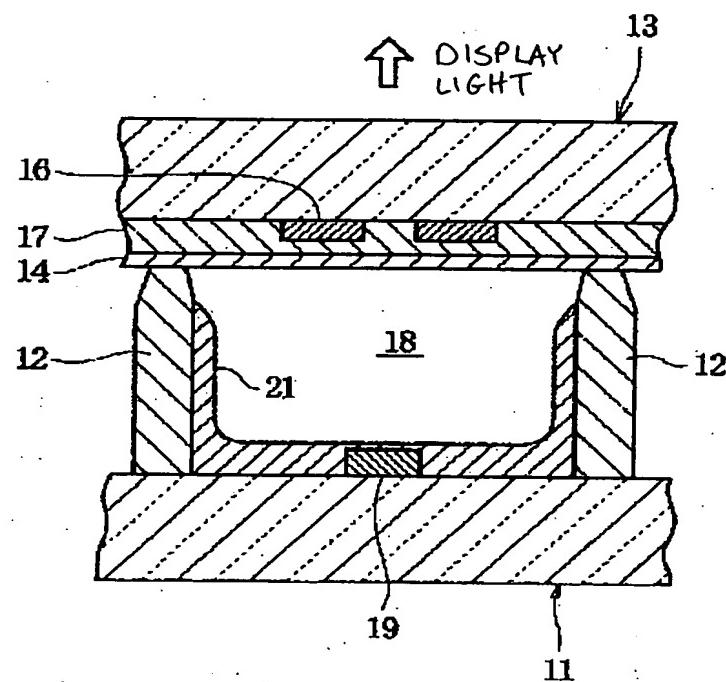
[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig.1 is a partial cross-sectional view of a PDP having a protective film manufactured using a coating solution of an embodiment of the present invention.

5 [DESCRIPTION OF THE CHARACTERS]

14 protective film (FPD protective film)

FIG. 1



14 PROTECTIVE FILM  
(FPD PROTECTIVE FILM)